

Inferolateral Retraction Reduces the Risk of Thermal Injury to Biliary Structures

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ABSTRACT

Objectives: Do various traction techniques significantly change the anatomic position during laparoscopic cholecystectomy?

Methods: 16 cadaveric liver specimens were dissected and measurements were taken between structures in the triangle of Calot. Measurements were taken while traction was placed on the infundibulum in the inferolateral, cephalad and anatomic positions. Thermal necrosis data was measured one week post-injury in a rat model for Non-contact Yag laser, Quartz, Sapphire tip, and electrocautery.

Results: Inferolateral traction provided statistically significant increases in distance ($P < 0.01$) between the critical biliary structures. The increase in length by cephalad traction on the gallbladder was not statistically significant. Depth of necrosis for the devices were: cautery 1.03 mm, sapphire tip 0.63 mm, non-contact Yag laser 2.13 mm, and bare quartz tip laser 1.05 mm.

Conclusion: Inferolateral traction produced a statistically significant increase in distance between the critical biliary structures. This was not demonstrated with cephalad traction. We recommend avoiding thermal dissection in the Triangle of Calot due to the thermal devices necrosis depth in relation to the proximity of the biliary structures.

Key Words: Traction, Biliary structures, Laparoscopic cholecystectomy

INTRODUCTION

One of the most treacherous major complications of laparoscopic cholecystectomy (L.C.) is bile duct injury, occurring at a rate of 0.4-0.6%.^{1,4,5,7,12,14,16,18} Cagir et al conducted a retrospective analysis of *open* cholecystectomies and reported a rate of .03% for bile duct injuries.² Therefore, the rate of bile duct injuries is a 14-fold increase when compared to open cholecystectomy. In a national survey by Deziel et al of 77,604 laparoscopic cholecystectomy cases reported the cystic duct leak and bile duct strictures account for 49% and 16% respectively for bile duct injuries.

These injuries appear to be related to the proximity of the Triangle of Calot structures, plus the loss of three dimensional depth perception, anatomic confusion, or possible delayed necrosis from thermal devices. In order to evaluate the risk of delayed injury presentation from thermal devices used within the Triangle of Calot, the relative distances between these critical structures in cadaveric specimens was compared to the known necrosis depths for laser and electrocautery. The relative impact of cephalad and inferolateral traction on the gallbladder and biliary structures can be measured with the portal triad completely intact.

MATERIAL AND METHODS

Sixteen fresh cadaveric liver specimens were obtained. The resected liver specimen included the lateral margin at the right segmental fissure, the medial margin at the left segmental fissure, and the inferior margin including the first through third duodenal segments. Measurements were taken *between* the cystic duct, at the level of the infundibulum, and between the following structures: the common hepatic duct (C.H.D.), right hepatic duct, and the cystic artery. These measurements were taken in triplicate after minimal dissection to allow for identification of the structure.

Three measurements were taken between these structures. The first measurement recorded proximity in the anatomic position and served as the control. The second measurement defined the proximity with cephalad traction placed on the infundibulum of the gallbladder. The third mea-

Table 1.

Proximity data measured from the cystic duct to the three critical biliary structures.

Anatomical Structure (measurement taken from Cystic Duct to:)	Anatomical (mm)	Cephalad (mm)	Inferio-lateral (mm)	p<
Cystic Artery (N=16)	1.49 ±1.83	1.89 ±1.57	3.63 ±2.00	0.01
Right Hepatic Duct (N=16)	13.90 ± 5.28	15.30 ± 9.09	23.30 ± 10.57	0.05
Common Hepatic Duct (N=16)	3.05 ± 2.46	6.94 ± 4.93	11.63 ± 7.33	0.01

*Bolded data denotes significance relative to Anatomic position.
p values determined using ANOVA (Student-Newman-Keuls treatment)

surement required inferolateral traction placed on the infundibulum of the gallbladder. In order to maintain anatomic positioning a second assistant was required. Careful attention was paid to reproduce actual L.C. conditions as closely as possible, with measurements taken as applicable for this operation. Data obtained from previous experiments using a rat liver thermal necrosis model which evaluated depth of thermal necrosis from cautery, sapphire tip laser, non contact YAG laser, and the bare tip quartz laser were then applied to the obtained traction measurements to evaluate the potential for injury. Equipment used for the thermal devices was: standard Valley Lab paddle blade electrocautery set at 30 watts, (Lasersonics) sapphire tip contact laser at a setting of 15 watts, standard Yag laser (Lasersonics), non-contact quartz fiber at 30 watts, and lab fashioned bare quartz contact fiber at 15 watts.

Descriptive statistics were calculated for all measurement. P values were determined using ANOVA (Student-Newman-Keuls treatment).

RESULTS

Inferolateral traction produced a statistically significant increase in distance between the cystic duct and all three biliary structures. Cephalad traction produced a statistically significant increase in length only when compared with the common hepatic duct (6.94 mm) (Table 1). The sapphire tip laser affords the shortest depth of necrosis (.63 mm). The most frequently used thermal device, electrocautery, has an increased depth of penetration of 1.03 mm. The greatest depth of penetration is seen with the non-contact YAG laser at 2.13 mm (Table 2).

DISCUSSION

Inferolateral traction produced a statistically significant increase in the distance between the cystic duct and the critical hilar structures. By applying experimentally obtained thermal necrosis data to the cadaveric measurements, an appreciation for the proximity of these structures and the potential for injury from thermal devices can be obtained.

One etiology for a cystic stump leak and bile duct stricture is the inadvertent application of cautery to the respective tissues, causing disruption of the vascular integrity and eventual necrosis. The briefest exposure of the cystic stump or bile duct to cautery may result in stricture and/or necroses that may not become immediately apparent. Inflammation and infection may exacerbate the thermal

Table 2.

Thermal Necrosis (at one week)

Thermal Devices	Depth of Penetration (mm) ± SD
Cautery (N=29)	1.03 ± .29
Sapphire Tip (N=27)	0.63 ± .18
Non Contact Yag (N=19)	2.13 ± .22
Bare Quartz (N=10)	1.05 ± .37

*End point used was complete dissection through portal tissue with hemostasis

insult. By noting the distance between these critical structures and the increased distance afforded by inferior lateral traction, the laparoscopic surgeon can reduce the risk of thermal injury.

Deziel et al suggested Inferolateral traction, as opposed to cephalad traction, produced the greatest distance between the critical biliary structures.³ Similar suggestion have been made by Hunter and Berci during SAGES (Society of American Gastrointestinal Endoscopic Surgeons) discussions. The measurements obtained from this study confirms these perceptions. Other options to reduce the incidence of biliary injury include blunt dissection from the infundibulum to the hepatic hilum, careful identification of the junction between the cystic duct and the common bile duct, and the liberal use of intraoperative cholangiography to clarify the anatomy before extensive dissection.

CONCLUSION

The injury to the biliary system remains one of the most devastating complications in laparoscopic cholecystectomy today.^{2,7} Inferolateral traction coupled with meticulous dissection and the judicious use of cautery may reduce the risk of injury to these structures to the lowest possible level.

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